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Procedia Economics and Finance 31 (2015) 797 – 802

Procedia Economics and Finance

www.elsevier.com/locate/procedia

INTERNATIONAL ACCOUNTING AND BUSINESS CONFERENCE 2015, IABC 2015

Facility Layout for SME Food Industry via Value Stream Mapping and Simulation

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Abstract

Redesigns or changes of the physical factory layout will involve high costs. Applying simulation and value stream mapping (VSM), the manager can see the impacts before the implementation and transform the organization into a minimal cost. VSM is a map of the *current* and *future* state of a production system that identifies each step throughout the production process by allowing organization to understand where and what need to be eliminated. In this paper, two types of layout are proposed using the Systematic Layout Planning, which is a systematic way of generating layout alternatives. The proposed layouts are evaluated using the ARENA simulation. The purpose of this paper is to present an application of VSM with simulation during the design of facility layout of an organization. Hence, to further the continuous improvement goals of facility layout, researchers have suggested the use of simulation and discusses the integration of VSM and simulation. The ultimate goal is to design and introduce a *value stream* that optimises the flow of the entire system - distance between machines, frequency of material movement and capacity.

Peer-review under responsibility of Universiti Teknologi MARA Johor

Keywords: Facility Layout; Production Process; Simulation; Small Medium Enterprise; Value Stream Mapping

1. Introduction

The Small Medium Enterprises (SME) is the largest contributor in the business sector in Malaysia and it is a major factor of the country's economy. Based on the resources from the smecorp website, SME also includes the whole activities involving the enterprise business. Enterprise can be divided into three parts, namely micro, small and

Peer-review under responsibility of Universiti Teknologi MARA Johor
doi:10.1016/S2212-5671(15)01169-7

medium. Looking at the industrial world nowadays, the most important concern is related to the issue of waste and the work force employed (Norani, A. et. al., 2012).

This waste problem often occurs for all enterprise business networks around the world. In essence to protect customers against the ritualistic enterprises, the employees are asked to work effectively and efficiently. However, the number of labour will require high cost and the financing balance is totally ineffective. Looking at this case, the enterprise should solve this problem by reducing wastage such as minimizing the total workforce and shorten the waiting time during the production process of a product so that the delivery of goods to customers more faster.

Generally, the objective of an enterprise is to generate a large profit. Huge profits can be obtained if the waste problem is resolved. At the beginning of the operations, the company should first identify the problems that can cause waste. There are seven elements in identifying waste of overproduction, inventory, transportation, waiting, motion, over-processing and correction (Jared, L., 2001). In solving the waste problem as well, the most important thing to take into consideration is the bottleneck problem. The term refers to a bottleneck of process in an operation where capacity is less than the demand placed upon than operation. Bottleneck is a problem that is common to manufacturing companies (Norani, A. et. al., 2012).

Based on the previous studies, the method often used in solving the waste problem is VSM. This method can be defined as the process of flow sketch for the added and non-added value in producing products ranging from raw materials up to be good product to deliver products to customer (Hines and Rich, 1997). In addition, VSM is visually mapping all the flow of information to prepare a future map with a right method (Hines, Rich et. al, 1998).

VSM is a method that can help identify waste during the production process runs. VSM is also a tool for mapping the value stream for each of the process so that it can determine which activities can provide value added and non-value added (Rother and Shook, 1999). By using the VSM, the information flow particularly for production lead time will be identified and the use of VSM is also more focused on the product value stream (McDonald, T. et. al., 2002). Rother and Shook (1999) stated that the VSM is a pencil and paper tools and it can only provide a static picture of the process of producing a product. Thus, simulation will also apply in interpreting the VSM.

There are several steps that should be taken before applying the VSM method. First, the company must determine the product or who want the added flow better. Then, create the form of the original flow of the production process that revealed problems during the process took place. After that, create the future state map that should be improved based on identified problems. Next is to transfer the identified problems to the new map simulation (Abdul Malek, F. and Rajgopal, J., 2007). Norani, A. et. al., 2012 has been combining simulation techniques to improve the facility layout for snack food manufacturing company. However, improvements must be performed using VSM as an overview of the VSM will able to assist in identifying problems related to waste.

2. Background of organization

Most of the enterprises in Malaysia were helped in improving the country's economic position. Among the well-known enterprises is SME. This study will be focusing on XYZ Company which is conducting SME of snack food. XYZ Company is a snack food processing factory that has a small shop with small quantities of output. The products are based on tapioca, banana and sweet potato. XYZ Company has been facing problems in producing higher volumes of products, particularly to cater to the increase in demand during the festive seasons. The problem has to do with managing employees' time as they are required to work overtime and go on more shifts in order to fulfill increased orders. As the products are in good demand in the market, the company enlarged the processing factory and added new products. They installed a cutting machine and a new fryer to increase the production capacity.

In the current process, it involves seven steps of activities. The first step is peeling the tubers and separating it according to size. The second step is the cutting process using a special non-adjustable cutting machine. The third step is the rinsing and filtering process to remove dirt and other unwanted foreign matter. The fifth step is frying the tapiocas using fryer stoves, conveyer machine and dryer machine. Then, the tapioca will undergo the cooling process and filtered broken chips. The final step is packaging and labeling process.

XYZ Company has 21 workers. Ten workers are allocated to the peeling process, two workers for the cutting process, one worker for rinsing and filtering, three workers to the frying process, one worker for cooling process, another one worker for the filtering broken chips process and the remaining three workers for the packaging and labeling process. For machine capacity, this company has five machines that are operated manually. There are fryer

stoves, cutting machine, conveyer machine, dryer machine and packaging machine. The existing facilities layout of the factory is a line-flow layout and is arranged in a linear path.

3. Research Methodology

This study examines the current plant layout. There are several elements in the layout that need to be considered in this study which are distance between machines, room size, frequency of material movement, flow of information and communication, safety and capacity that would be evaluated so that recommendations could be made to improve the current facilities layout of the production process.

The systematic layout planning (SLP) is widely adopted by enterprises as an approach of the layout design guidelines and is one that has been proven (Yang et. al*.,* 2000). SLP includes three stages which the first stage constitutes processing input data and activities, the information of which were obtained from the daily work schedules and plant layout. According to Canen and Williamson (1996), it is an important for a manufacturing to have an effective layout design.

Simulation is the process for the operation of the system to design a model of a real system and conduct experiments with this model to understand the behaviour of the system or evaluate various strategies (Shannon, R., 1975). A model is a representation of a system or process that incorporates time and the changes that occur over time.

The simulation model can help managers see the effects before and after implementation which are the impact of layout changes and resource reallocation, without huge investment (Van Landeghem and Debuf 1997, Rahn 2001). In most companies, especially small companies are difficult to introduce a new concept. By combining simulation with the visual map of VSM, faster adoption can be achieved and there will be less resistance to change from the workforce.

In recent years, VSM is a mapping tool maps information that flows signal and control the material flows. The material flow path of the product is traced back from the final operation in its routing to the storage location for raw material. This visual representation facilitates by helping to identify the value-added steps in a value stream and eliminating the non-value added steps or waste (Rother and Shook 1999).

Despite its success, VSM has some drawbacks. To address these shortcomings while preserving the intuitive set of symbols of VSM, we propose to use simulation as a documentation and implementation tool. Simulation models are built by using computer software and applied to the real world cases (Van Landeghem and Debuf 1997; Van Landeghem 1998; McDonald et. al., 2000; Rahn 2001). Simulations are used to model manufacturing processes as well as evaluating alternative scenarios of future state maps.

4. Analyses and Findings

The analysis and findings will show the differences between the current state and the future state of XYZ Company facility layout. The facility layout is designed based on value stream mapping (VSM) technique and simulation. Since VSM is a paper and pencil tool, it does not detail the production process and it will be supported by simulation using ARENA software. Therefore, we have two phases.

The first phase is to construct a paper and pencil VSM of one product. This will obtain the current and future state map. Fig. 1 shows the current state VSM. It consists of seven step of process. In this figure, it also shows the information of the spatial distance in meters between workstations and the time taken in minute to process the chips for each seven steps.

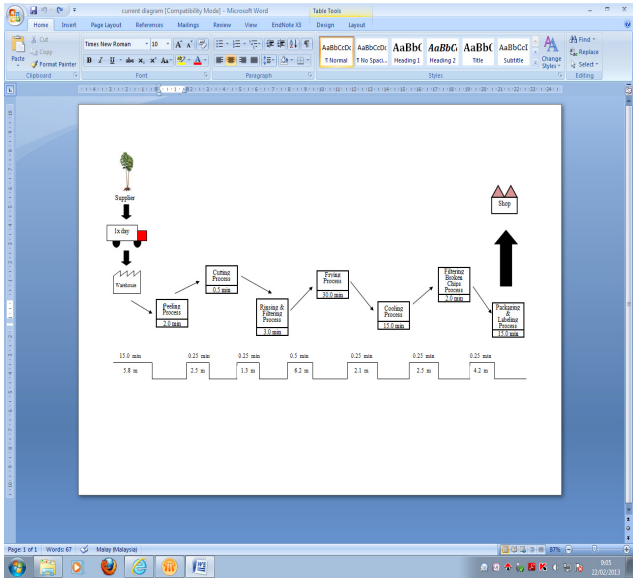

Fig. 1. Current State VSM

The future state VSM shows in Fig. 2. Before designing the future state VSM, we also got some information and advices from the Malaysia Agricultural Research Development and Development Institute (MARDI). This figure shows the information of the spatial distance in meters between workstations and the time taken in minute to process the chips. It consists of only six steps of process which are peeling process, cutting process, rinsing and filtering process, frying process, oil removal process and packaging and labelling process.

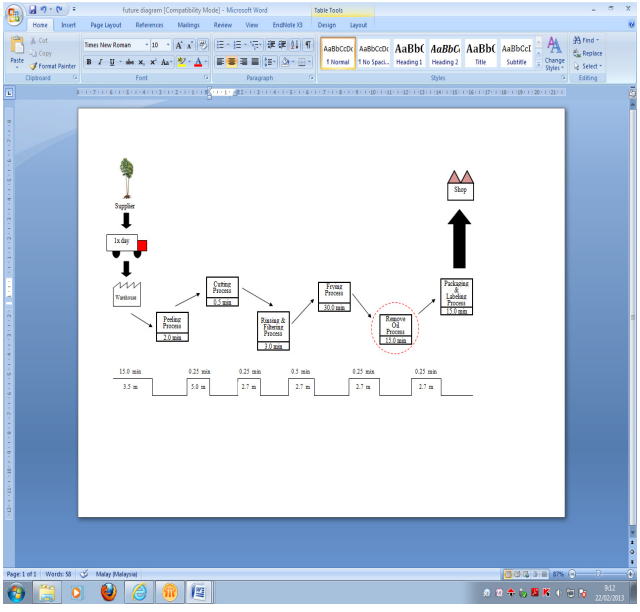

Fig. 2. Future State VSM

In second phase, we built the simulation model based on the current and future state maps VSM. This phase will yield a model which results can be compared to the current production process. After that we validated the model. It is important to generate trust in the simulation model among users and process owners at this phase.

Fig. 3 shows the simulation model based on the current state map of XYZ Company while Fig. 4 shows the simulation model of future state map for XYZ Company using ARENA software.

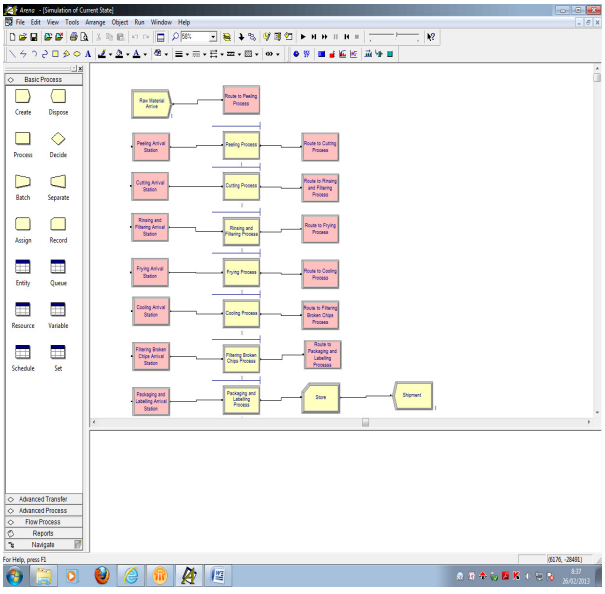

Fig. 3. Simulation Model of Current State

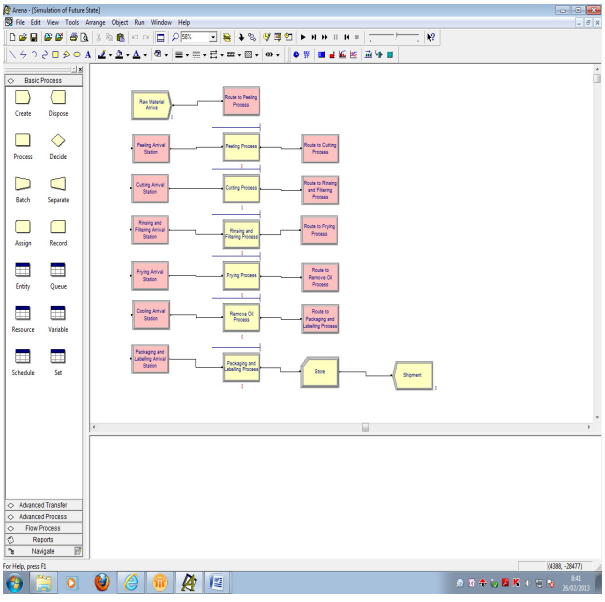

Fig. 4. Simulation Model of Future State

Looking at the current layout, there appear to be several elements that the XYZ company must take into

consideration when designing the new layout. These elements are the distance between activities and the time taken to finish up each process activities which include lead time. Based on future state model, it will propose a new factory layout incorporates optimum distances between activities and the process time taken.

5. Conclusion

VSM provides the model and data that will make simulation becomes easier to be done. Simulation gives immediate assessment of proposed changes to the model. Besides that, simulation is cheap, quick and easy to test all the data and ideas. VSM and simulation are a natural combination that was implemented in many studies. In this paper, this combination will improve the facility layout and flow for XYZ Company.

The new proposed layout based on future state has been demonstrated to be able to improve spatial distances between machines, between workstations and between rooms directly related to the series of production process. Besides that, the total value of the process time taken for each activity can also be improved. By comparing the flow diagrams of the current production process and the proposed new process, it is shown that the distance between workstations and the process time is substantially reduced. Therefore, the workers will move faster and the productivity increases. This will lead to a reduction in the variable cost of daily operation.

Acknowledgements

The authors would like to acknowledge the financial support received from Universiti Teknologi MARA (UiTM) Johor.

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